NASA TECH BRIEF

Marshall Space Flight Center

Manganese Bismuth Thin Film for Large Capacity Digital Memories

The problem:

Research into the employment of manganese bismuth/(Mn/Bi) for thin films used in optical memories, was in the past, very limited. To obtain accurate memory characteristics in regard to the write, read, erase, and data retention operations was very difficult.

The solution:

Material and system research was done which defined more clearly the characteristics of manganese bismuth materials, relevant for use in an optical memory system.

How it's done:

Optical memory characteristics of Mn/Bi involve the laser Curie point writing properties, the repeated cycling effect, the read-out signal characteristics, the erasure field requirements, the information retention characteristics, and the effect of film demagnetization.

Mn/Bi has two crystal structure phases: the normal (low temperature phase) and the quenched (high temperature phase). The Curie temperatures of the normal phase and quenched phase are 360°C and 180°C respectively.

Mn/Bi films, prepared in its quenched state, will slowly transform back to its low temperature phase under normal operating conditions. Repeated heat cycling on quenched films can be done, without interference from this transformation. When film spots are heat cycled, the transformation time-constant increases as the temperature rises. At 180°C the time-constant is equal to about 40 milliseconds. If the spot is above 180°C for 0.5 μ sec during laser writing, we should see an effect upon the optical memory characteristics after about 10^5 cycles. Spots have been cycled up to 10^6 times before the signal-to-noise ratio becomes less than one. When examined under the microscope, there is no evidence of physical damage. However, the signal will disappear as the writing power increases due to the quenched film gradually transforming into the normal phase.

Temperature is one of the properties that affects the memory read-out characteristics. The maximum read-out signal is attained when the film is operating at about 250°C.

To erase a written spot, an external magnet field must be applied. The field required for a perfect erasure (for the normal and quenched phase films) is approximately 500 oersteds.

There is no evidence of spontaneous loss of stored information in either phase of the material within a temperature range of room temperature to 300°C. Although the quenched film transforms back to the normal phase, the magnetization direction remains unchanged. Therefore no loss of information occurs. Cooling of films in liquid nitrogen will cause demagnetization, as will heating through the Curie temperature. The operating temperature is therefore limited to a range between 77°K and 633°K.

Note:

Requests for further information may be directed to:

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Source: D. Chen, R. L. Aagard, F. M. Schmit and T. S. Liu of Honeywell Inc. under contract to Marshall Space Flight Center (MFS-21246)

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